Gastrointestinal Illness Strikes the Village of Sortumme

A *Disease Detectives* Exercise from the
Centers for Disease Control and Prevention

TEACHER'S GUIDE and ANSWER KEY

Instructions

- Prepare student by teaching the fundamental principles of epidemiology and outbreak investigation. Materials are available in "Background and Teaching Aids" on the EXCITE web site. At a minimum, students should be familiar with the basic steps of an outbreak investigation.
- One excellent format for this exercise is to divide the class into small work groups of five to ten students and have each group assign a facilitator, a recorder, and a reporter. Ask individual students from the class at large to read the narrative and questions out loud. Then have students work in their small groups to answer the questions. Finally, have the groups report their responses to the class.
- Students can use a simple statistics program, such as Excel, to calculated attack rates and relative risk.
- The exercise is in six parts. Each part should be distributed independently and only after students have completed the preceding part. The total exercise requires approximately 3½ hours. An estimated time to completion is included for each part.

Learning Objectives

- Understand when and how to conduct a cohort study.
- Recognize the value of an epidemic curve and learn how to interpret one.
- Understand the role of bacteria in foodborne illness.
- Calculate and understand relative risk.
- Understand the limitations of a retrospective study.

* This exercise is adapted for high school use from a classic investigation conducted in Oswego County, New York, in 1940. The original case study is used each year in the Epidemic Intelligence Service (EIS) Summer Course, which trains incoming EIS Officers. This adaptation was created by Dr. Edwin Yu while at CDC in spring 2000 fulfilling a medical epidemiology elective during his final year of training at Cornell University Medical College.

✎ 1. Would you consider the situation in Sortumme an outbreak? Why or why not?

Answer:
An outbreak is the occurrence of more cases of a particular disease than expected in a given area, or among a specific group of people, over a given period of time. Having 46 out of 80 people develop acute gastrointestinal illness during a 24-hour period is clearly above the "expected," or background rate, of two episodes/person/year found in the National Health Survey.

Teacher's Note:
To determine the expected number of cases, or baseline, when an outbreak is not so obvious, you usually compare the current number of cases with the number from the previous few weeks or months, or from a comparable period during the previous few years. Sources of these data include

- health department surveillance records,
- hospital discharge records,
- mortality (death) records, and
- cancer or birth defect registries.

✎ 2. List the steps of an outbreak investigation.

Answer:
1. Prepare for field work
2. Establish the existence of an outbreak
3. Verify the diagnosis
4. Define and identify cases
5. Describe and orient the data in terms of time, place, and person
6. Develop hypotheses
7. Evaluate hypotheses
8. Refine hypotheses and carry out additional studies
9. Implement control and prevention measures
10. Communicate findings

Teacher's Note
The steps of an outbreak investigation are not fixed in order. In some situations control measures can and should be implemented immediately. Verification of the diagnosis may come at the same time as verification of an outbreak, or laboratory confirmation may come weeks after the investigation is over. Many components, such as the case definition, line listing, descriptive epidemiology, and hypothesis, are continually altered throughout the investigation, as investigators acquire additional information.

✎ 3a. Will you use a cohort or a case-control study to investigate the Sortumme outbreak? Why? What measure of association is most appropriate to compute for this type of study?

Answer:
A cohort analysis is appropriate because the population is small and well defined (all those who attended the church dinner), and, therefore, attack rates can be calculated. The attack rate ratio, or relative risk, is the appropriate measure of association.

✎ 3b. Is this study prospective or retrospective? Explain your answer.

Answer:
The study is retrospective because you are looking back on events that have already taken place. In a prospective study, you define a study group and follow their condition over a period of time.

✎ 4. You plan to interview the people who attended the supper. What information will you want to collect?

Answer:
Identifying Information
• name, address, phone number
• respondent (e.g., self, parent of child, spouse)

Demographic Information
• age or birth date
• sex
• occupation

Epidemiologic Information (exposures and contacts)
• what was eaten at the supper, how much, and when
• foods eaten before and after the supper (but before the illness)
• contacts with other ill people
• the person's role in food preparation and handling

✎ 5. What number will you use for the population at risk in this study? Why?

Answer:
Even though 80 people attended the dinner, for your analysis the correct the population at risk is 75. You can include only people for whom data have been collected.

✎ 6. As soon as epidemiologists have the necessary data, they develop an epidemic curve. How does an epidemic curve help in an investigation?

Answer:

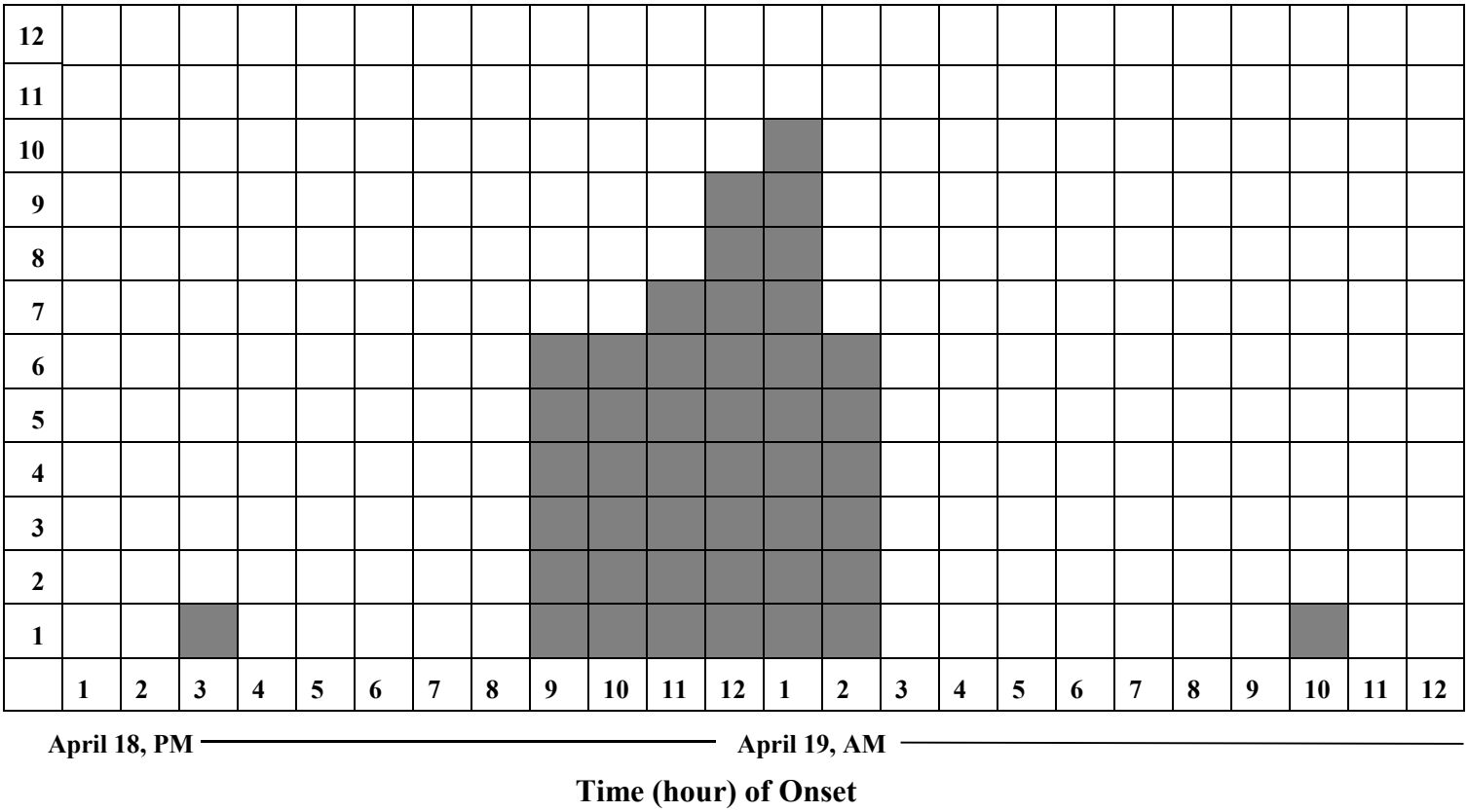
Epidemic curves are a basic tool of field epidemiologists because they

- provide a simple, easily understood visual of the magnitude of an outbreak,
- provide clues to the pattern of disease spread in a population,
- depict where you are in the course of an outbreak (still on the upswing, on the downslope, or past the outbreak), and
- indicate outliers (cases that do not fit into the body of the curve), which, if they are part of the outbreak, may point directly to the source.

✎ 7a. Using data from the attached line listing, graph the cases by time of onset of illness, to create an epidemic curve. Label the axes and add an appropriate title.

Answer:

Cases of Illness, by time of onset of symptoms,
Village of Sortumme



Teacher's Note
Because time, which is plotted on the *x*-axis, is continuous, an epidemic curve is drawn as a histogram (no gaps between adjacent columns), not as a bar chart. If data are available from the pre-outbreak period, the *x*-axis should begin well before the onset of the outbreak. The pre-outbreak period illustrates the background, or usual number of cases, and for a disease with a human host like hepatitis A, may include the source case of the outbreak.

✎ 7b. What does this epidemic curve tell you? What might you learn from the outliers?

Answer:
The Sortumme Village epidemic curve rises sharply, peaks, and then declines rapidly, suggesting common source exposure with a short incubation period (with some cases even occurring during the church dinner). The peak and decline of the curve indicate an end to the outbreak. There are two evident outliers – the early outlier is particularly important because it suggests that the contaminated food was prepared and became contaminated sometime before 3pm.

✎ 8. Using data from the line listing in Part 2, calculate the incubation periods where possible, rounding to the half hour.

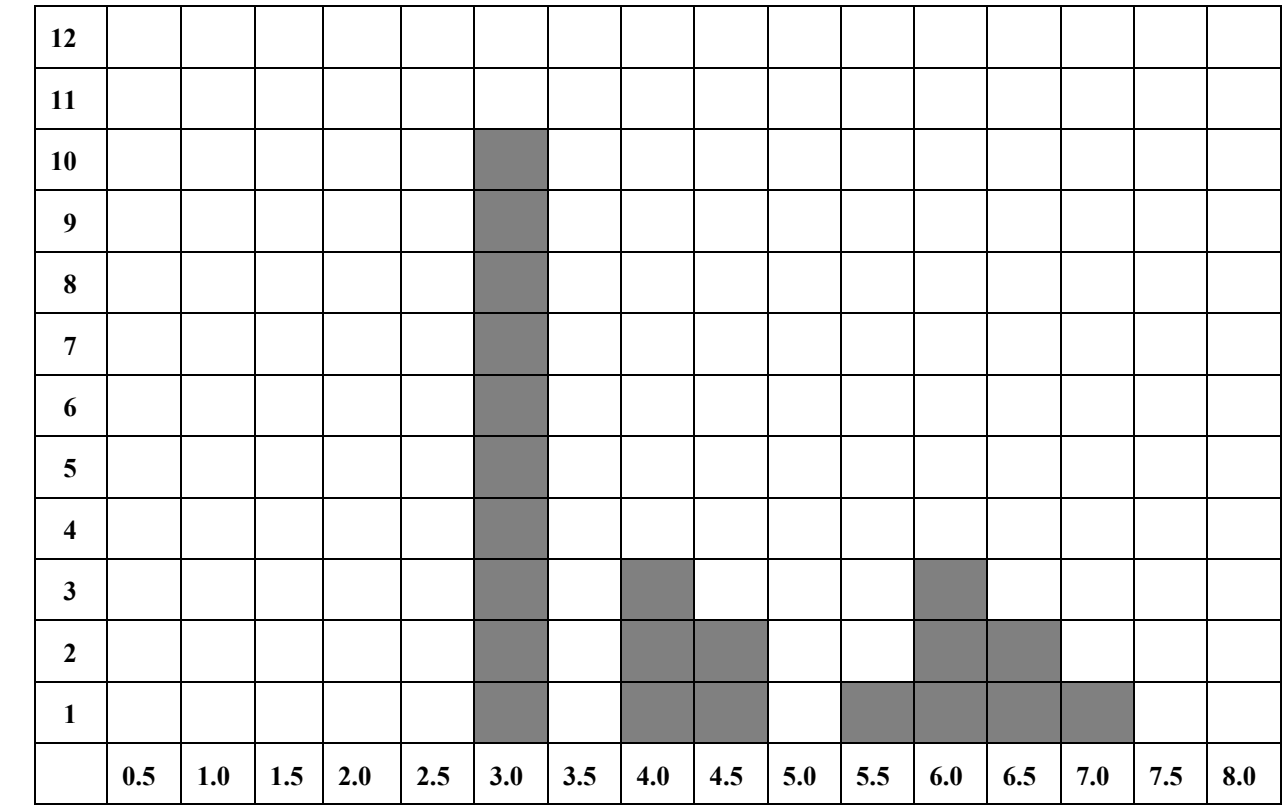
Answer:

Case ID#	Incub.	Case ID#	Incub.	Case ID#	Incub.	Case ID#	Incub.
2	4.5	9	3	32	3	58	3
3	6	10	4	33	3	59	7
4	6	14	6.5	39	3	60	4
6	3	21	3	48	6	65	3
7	3	27	3	52	4	71	5.5
8	6.5					72	4.5

✎ 9a. Graph the distribution of the incubation periods, using 1-hour intervals on the *x*-axis. Add an appropriate title and label the axes.

Answer:

Cases of illness, by incubation period in hours,
Sortumme Village



✎ 9b. How would you interpret this graph?

Answer:

The graph of the incubation periods is not symmetric, or normally distributed, but appears biphasic, suggesting two distinct incubation periods. The incubation period is noticeably shorter for people eating later (median = 5.5 hours for those eating from 6-8 PM; median = 3 hours for those eating after 9 PM), which tends to concentrate the peak.

Teacher's Note

This distribution of incubation periods might result from continuing enterotoxin production in the food over the course of the dinner, so that those who ate later got a higher dose, which would be consistent with an agent capable of generating preformed enterotoxin. Another possible explanation is that people who ate later ate more of the contaminated food and thus ingested more bacteria than those who ate early. This larger dose of enterotoxigenic/invasive bacteria could cause enough damage to produce symptoms early. The short incubation time of 3 hours, however, seems much more consistent with preformed enterotoxin than with high-dose inoculation with an agent having a moderately long incubation period.

✎ 10. Using the data from the line listing in Part 2, complete the table below.

Answer:

Attack rates, by items consumed at church supper

	Number of people who **ate** specified item				Number of people who **did not eat** specified item			
Food/Beverage	**Ill**	**Well**	**Total**	**Attack Rate (%)**	**Ill**	**Well**	**Total**	**Attack Rate (%)**
Baked ham	29	17	46	63	17	12	29	59
Spinach	26	17	43	60	20	12	32	62
Mashed potatoes*	23	14	37	62	23	14	37	62
Cabbage salad	18	10	28	64	28	19	47	60
Congealed salad	16	7	23	70	30	22	52	58
Rolls	21	16	37	57	25	13	38	66
Brown bread	18	9	27	67	28	20	48	58
Milk	2	2	4	50	44	27	71	62
Coffee	19	12	31	61	27	17	44	61
Water	13	11	24	54	33	18	51	65
Cakes	27	13	40	67	19	16	35	54
Vanilla ice cream	43	11	54	80	3	18	21	14
Chocolate ice cream	25	22	47	53	20	7	27	74
Fruit salad	4	2	6	67	42	27	69	61

✎ 11. Which food item is the most likely vehicle of infection? Why?

Answer:
Vanilla ice cream because it has
- a high attack rate among those exposed (80%),
- a low attack rate among those not exposed(14%), and
- was eaten by most of the people who became ill, so the exposure could explain most, if not all, of the cases.

✎ 12. Construct a 2 x 2 table to examine the association between illness and consumption of vanilla ice cream.

Answer:

Attack rate for consumption of vanilla ice cream

	Disease Status			
	Ill	**Not Ill**	**Totals**	**Attack Rate (%)**
Exposure to risk factor				
Ate vanilla ice cream	A (43)	B (11)	A + B (54)	A ÷ (A + B) = 79.6
Did not eat vanilla ice cream	C (3)	D (18)	B + D (21)	C ÷ © + D) = 14.3

✎ 13a. Calculate the relative risk for becoming ill from eating vanilla ice cream.

Answer:

$$\frac{79.6}{14.3} = 5.6$$

✎ 13b. What does this value of the relative risk tell you about the association between illness and eating vanilla ice cream?

Answer:
Eating vanilla ice cream made people 5.6 times more likely to become ill than were people who didn't eat vanilla ice cream.

✎ 14. Three people who became ill had not eaten vanilla ice cream. How would you explain this?

Answer:
Possible explanations:
- All three said they had eaten cake and chocolate ice cream. Perhaps these foods were cross-contamination from the vanilla ice cream via dishes, spoons, or servers.
- There may have been multiple vehicles.
- These three people may have remembered inaccurately.
- These cases could also be completely unrelated to the outbreak.

✎ 15. Compute the relative risk for consumption of cake and of chocolate ice cream. How does each correlate with the risk of becoming ill? How would you explain these correlations?

Answer:
Eating cake is weakly correlated with becoming ill (RR = 1.3) and might reflect
- an association due to preference for cake and ice cream,
- independently contaminated or cross-contaminated cake, or
- chance.

Eating chocolate ice cream was negatively correlated with becoming ill (RR = 0.7) and might reflect a tendency to eat either chocolate or vanilla ice cream, but not both.

✎ 16. Why is it necessary to show that the strain of *Staphylococcus aureus* isolated from Jane Petri is identical to the one isolated from the ice creams?

Answer:
Demonstrating that the strains isolated from Jane Petri and the ice creams are identical would then prove that Jane was the source, and knowing that would help you direct prevention efforts.

Teacher's Note

Not all strains of *Staphylococcus aureus* bacteria are capable of producing preformed enterotoxin. Only strains possessing a specific plasmid that encodes for this protein will have this ability. It is nearly impossible for another strain of *Staphylococcus aureus* to acquire the ability to produce preformed enterotoxin by random mutation alone. On the other hand, it is possible for other strains of staphylococci without this specific plasmid to acquire it by exposure to strains of staphylococci with the enterotoxin plasmid. This is also one of the mechanisms of transmission of bacterial resistance from antibiotics.

✎ 17. What are the limitations of a retrospective investigation?

Answer:

- People in the study may not remember their experience very well.
- They may not understand the interview form or questions.
- Unrelated illnesses may cause unexposed people to be counted as cases (e.g., those who developed acute gastrointestinal disease even though they did not eat vanilla ice cream).
- Food handlers may conceal facts because of real or imagined guilt.
- Once people are well, they are apt to remember less completely.
- Different interviewers may question people differently.